25 CM. SPHERES
6 CM. SPACING
NEGATIVE POLARITY
MEASUREMENT DIVIDER
HIGH SIDE = 7-125 Ω CARDS
LOW SIDE = 4.07 Ω SHUNT

No. 547
Amfile®

$\frac{3 \times 10^2}{.74 \times 10^{-7}} = 4 \times 10^9$

(161 is negative spark over of a 25 cm sphere gap at 6 cm spacing.)

Questions

1.) May I consider the Cigre Study Committee Curve (Fig. 2) as having a zero response time. $\left(\frac{U_{oc} - U_o}{S} = Tr = 0\right)$

2.) If $U_o = U_{oc}$ in Cigre Study Committee Curve, then I can consider that:

$$\frac{U_{oc} - 161}{S} = \text{ordinate axis scale}$$

3) I find some discrepancies in the equation:

$$\frac{(U_{oc} - a_2)^2}{S} = \text{constant}$$

at $S = .15$ $\qquad \frac{(U_{oc} - 161)^2}{.15} = \underline{4,780}$

at $S = 1.0$ $\qquad \frac{(U_{oc} - 161)^2}{1.0} = \underline{4,489}$

at $S = 10.$ $\qquad \frac{(U_{oc} - 161)^2}{10} = \underline{4,000}$

4) How do I interprete the results of a breakdown in air across an insulator, using a measuring divider with a response time = $\underline{19.7 ns}$

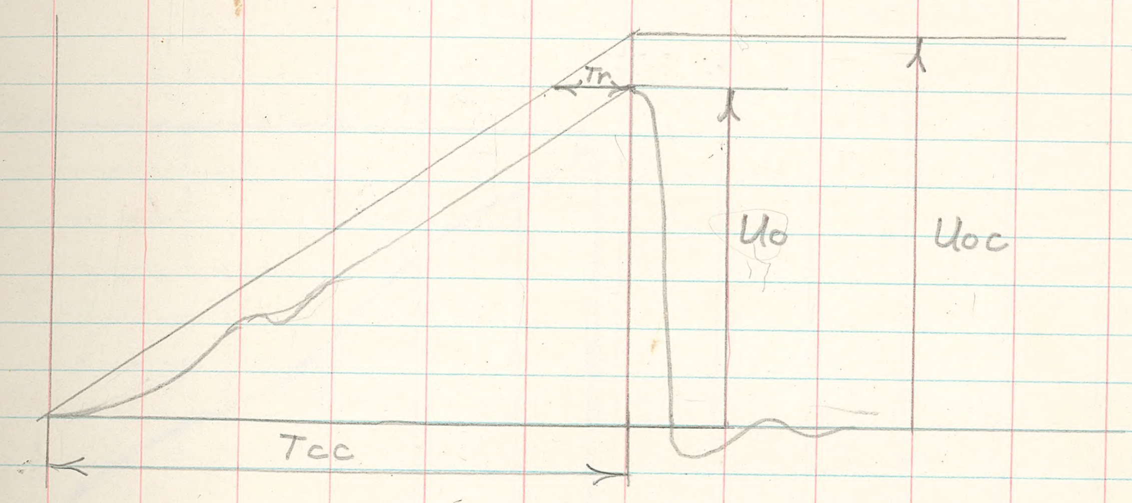
? If: $U_o = 302 KV$ breakdown in air @ 74 ns $\left(\frac{KV}{ns} = 4\right)$

and: $U_{oc} - U_o = S\,Tr$

then: $U_{oc} = S\,Tr + U_o$

$$\frac{U_0 - 161}{S} = \text{ordinate axis scale}$$

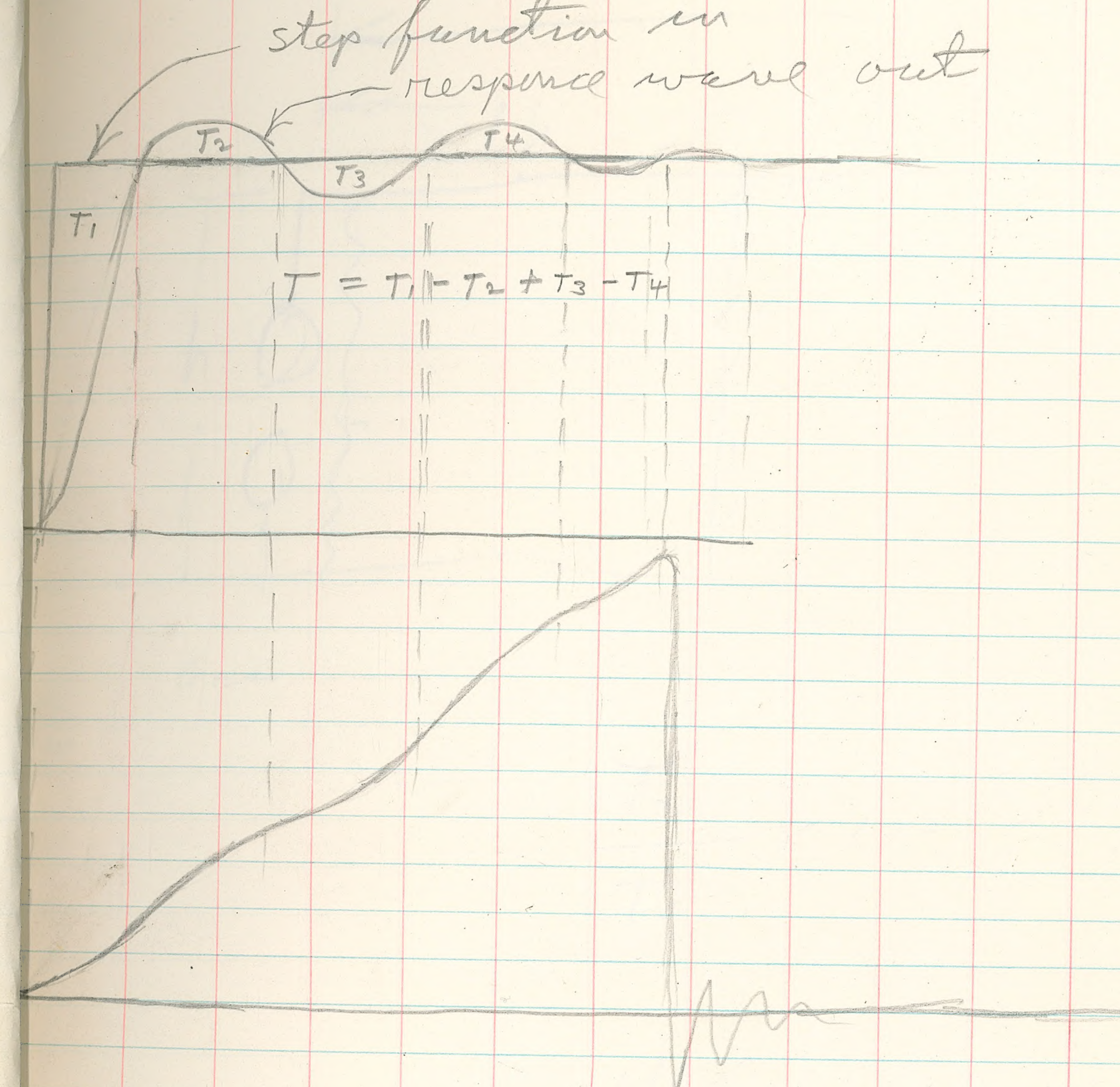
$$\frac{(U_{0c} - 161)^2}{S} = \text{constant}$$



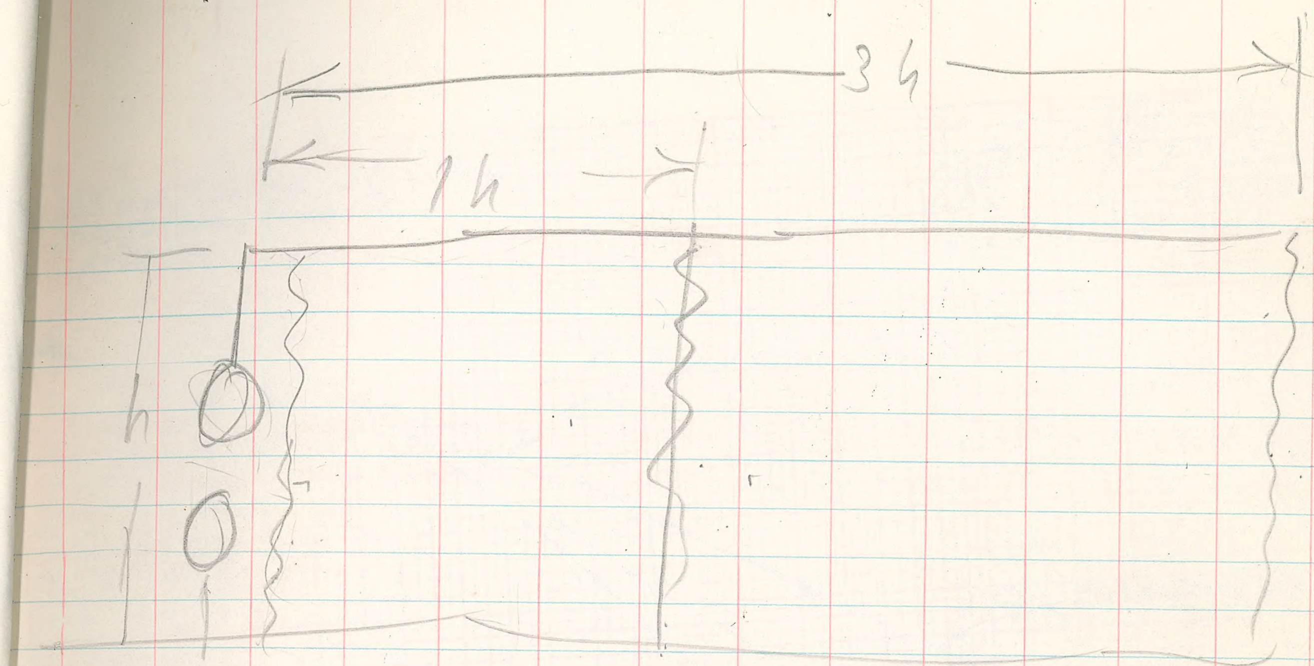
the measurement error is estimated at:

$$U_{0c} - U_0 = S\,T_r$$

$$\frac{U_{0c} - U_0}{S} = T_r$$


step function in
responce wave out
T_1
T_2
T_3
T_4
$T = T_1 - T_2 + T_3 - T_4$

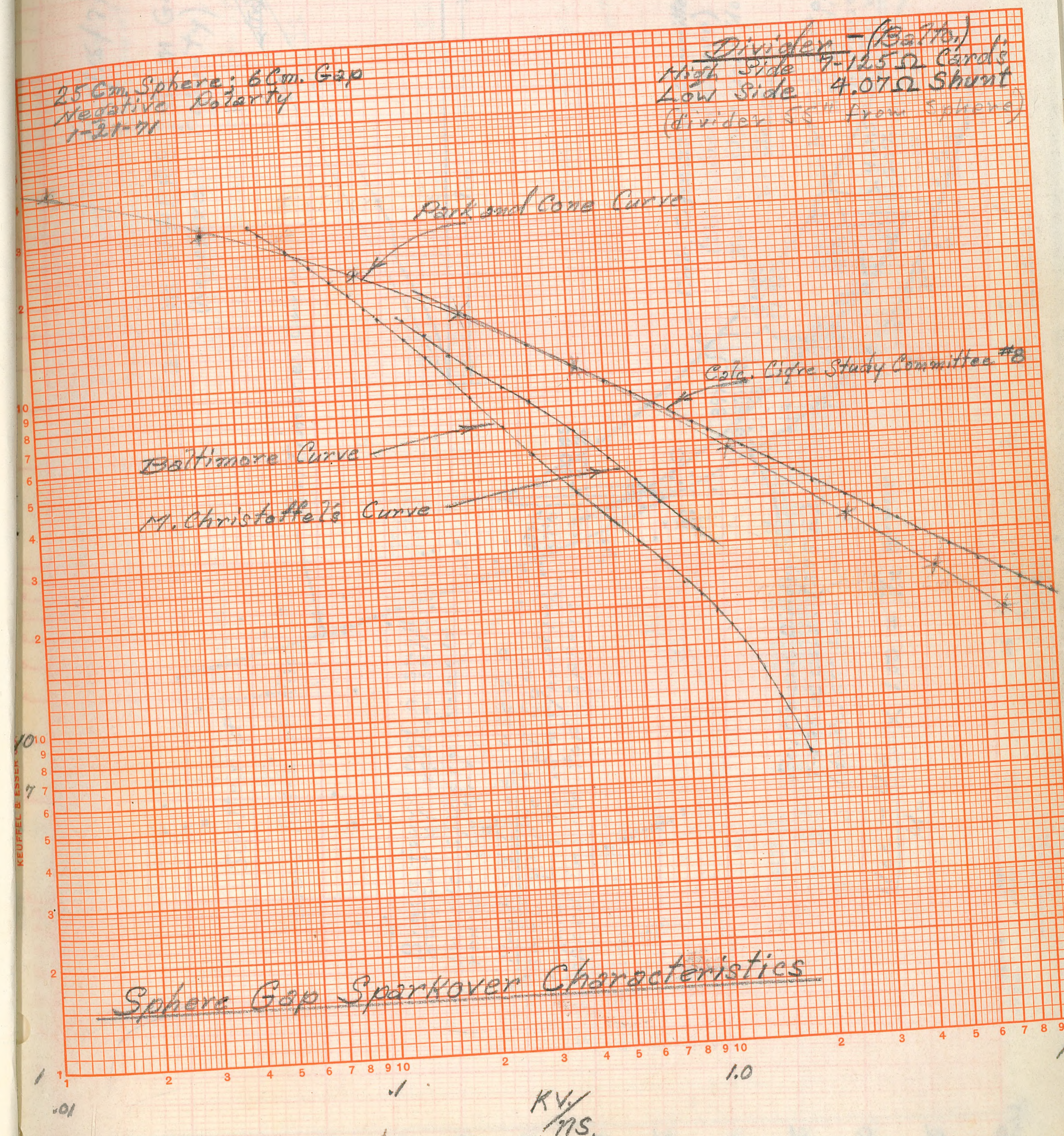
.060



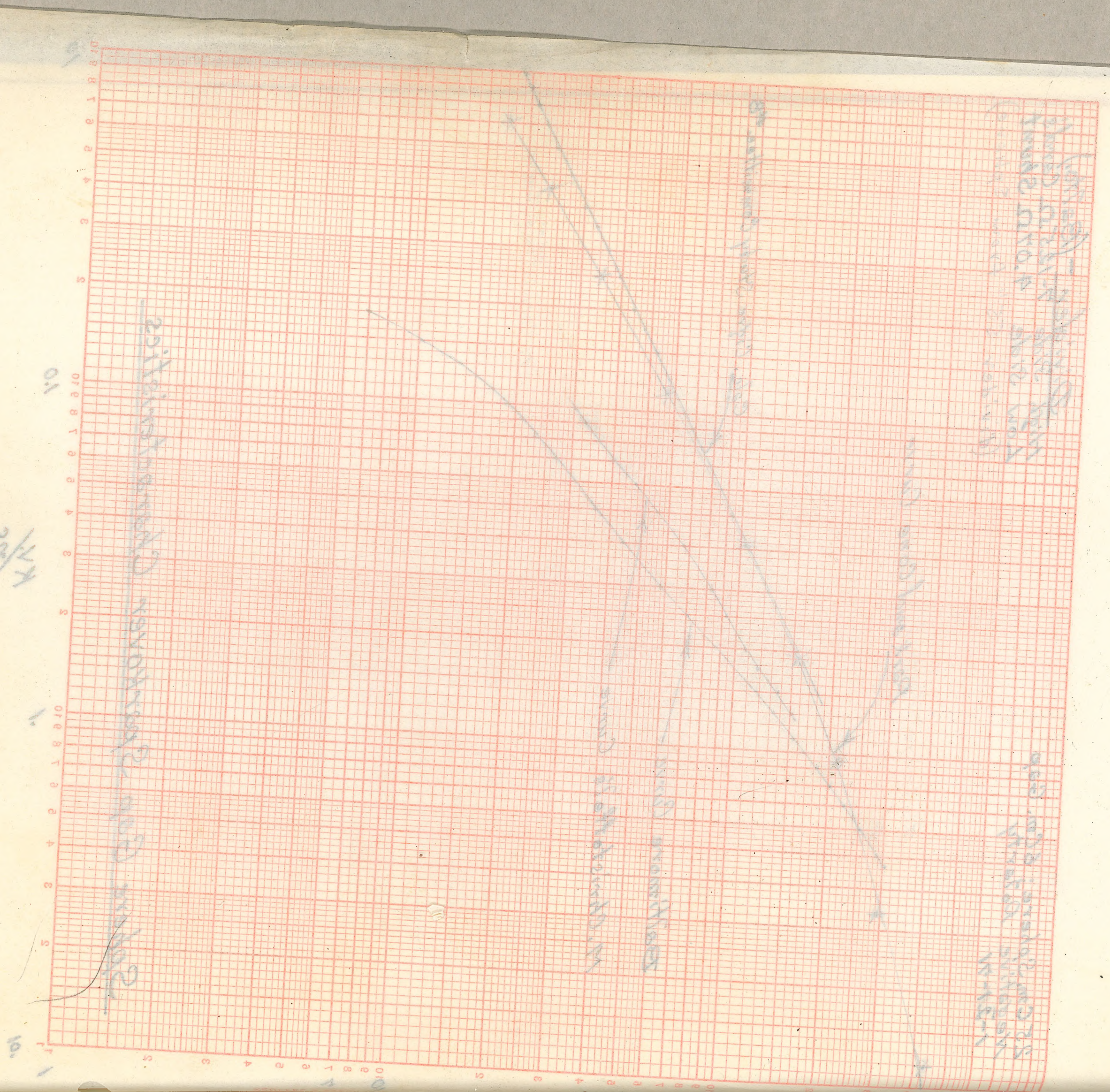
Osc

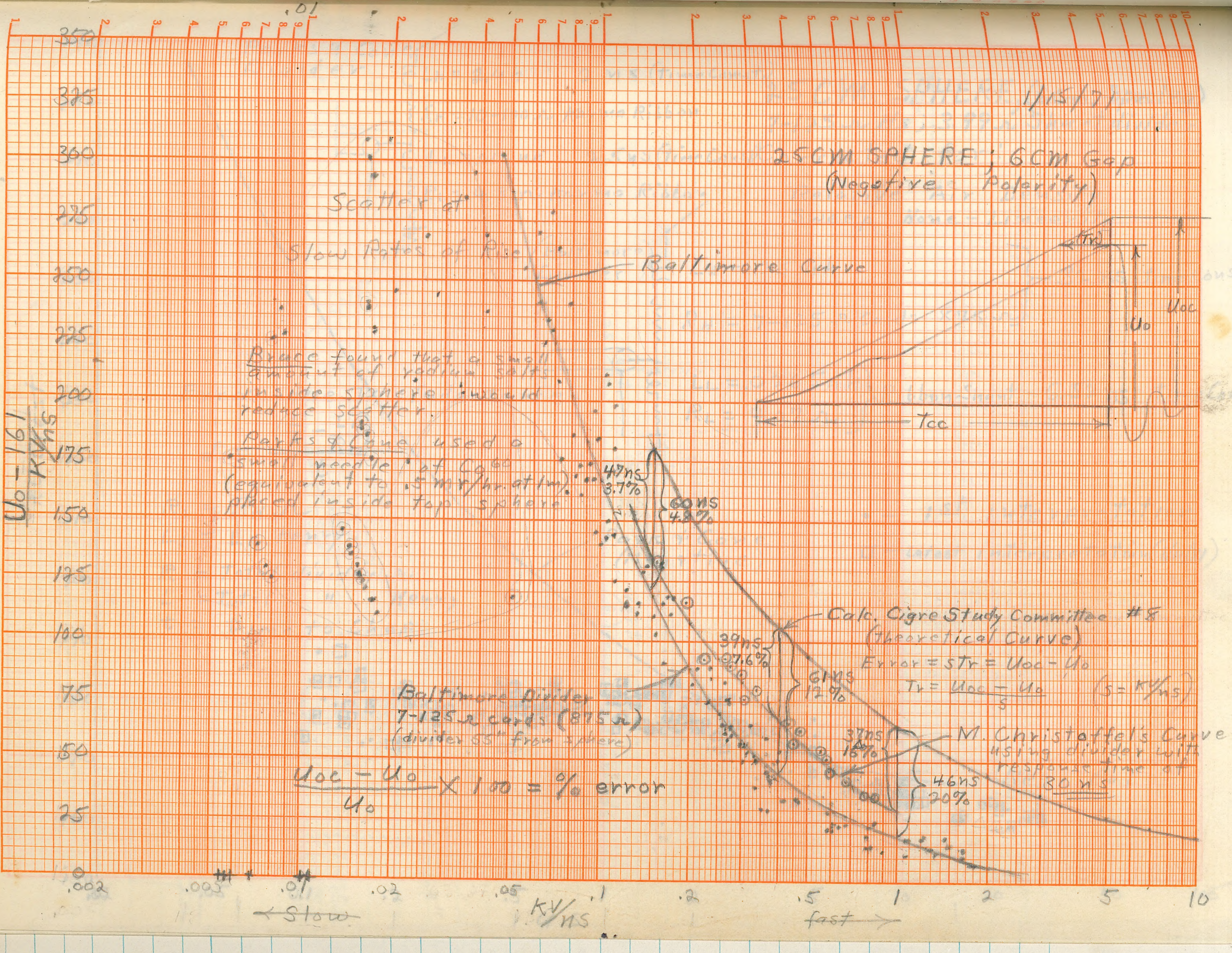
$$\frac{T_r}{T_a} \times 100 = \% \text{ error}$$

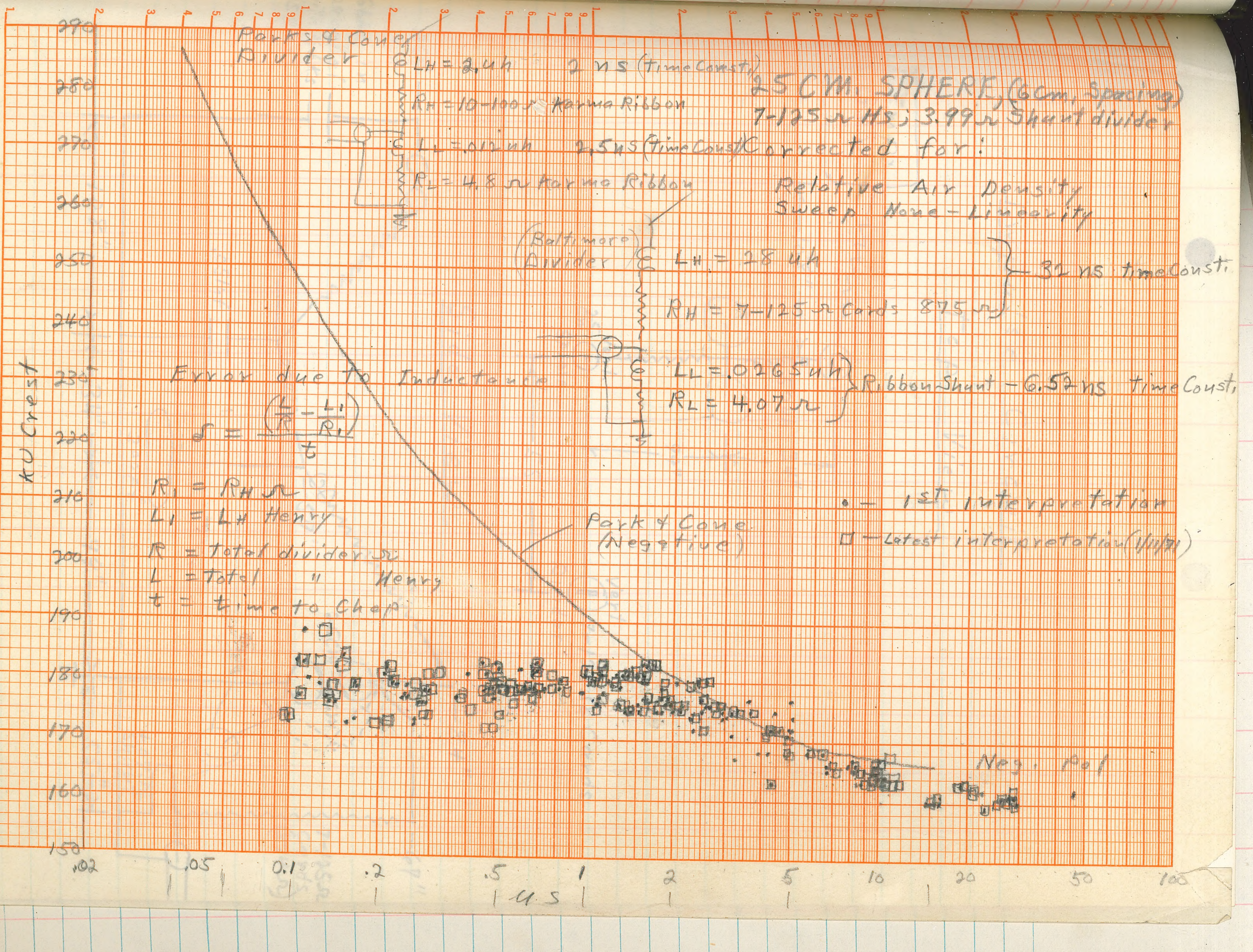
1 ft/ns speed of light

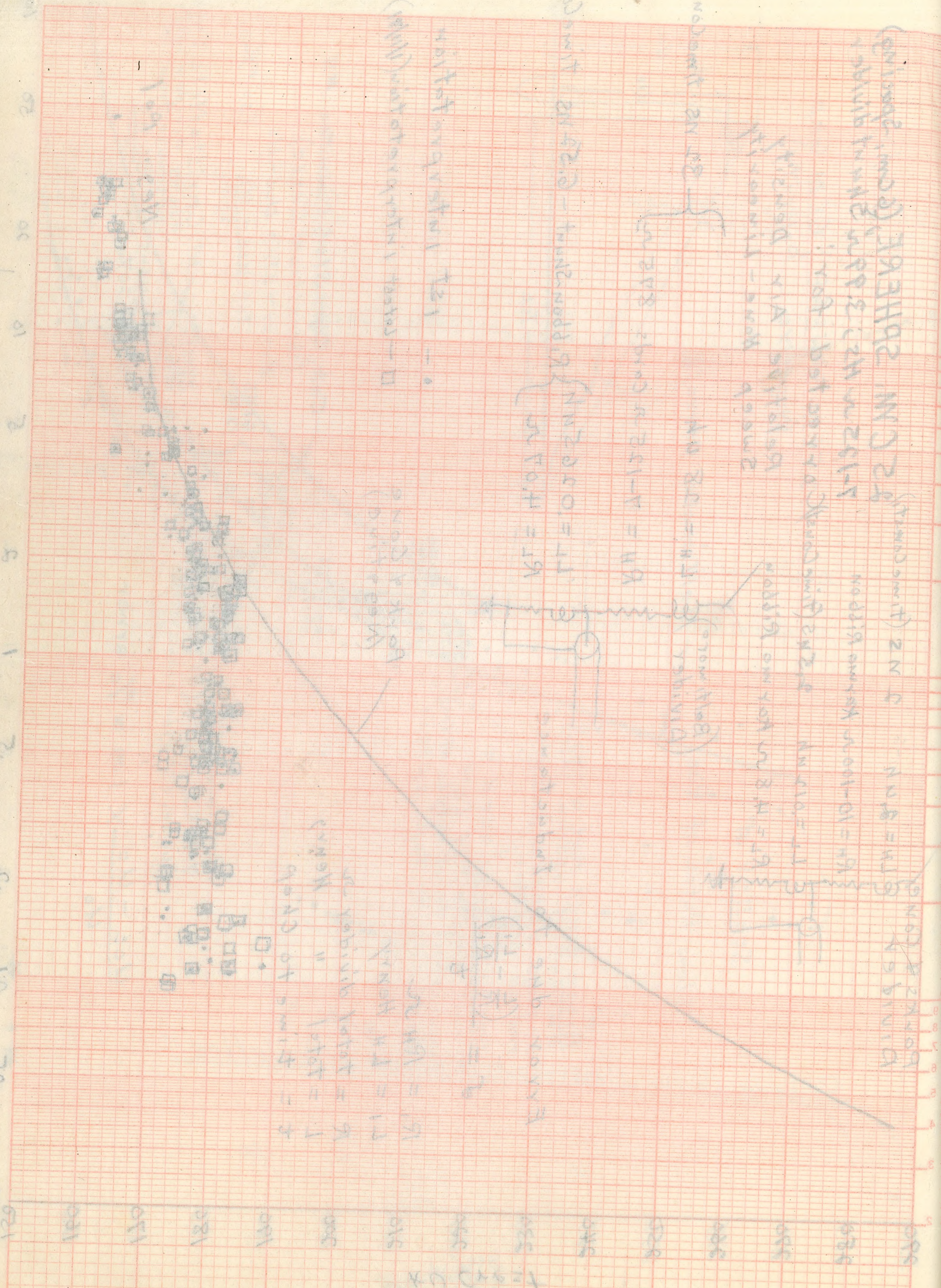


25 Cm. Sphere; 6 Cm. Gap
Negative Polarity
1-21-71
Divider - (Balto.)
High Side 7-125 Ω Cards
Low Side 4.07 Ω Shunt
(divider 55" from Sphere)
Park and Cone Curve
Calc. Cigre Study Committee #8
Baltimore Curve
M. Christoffel's Curve
Sphere Gap Sparkover Characteristics
.01
.1
1.0
10
KV/ns.



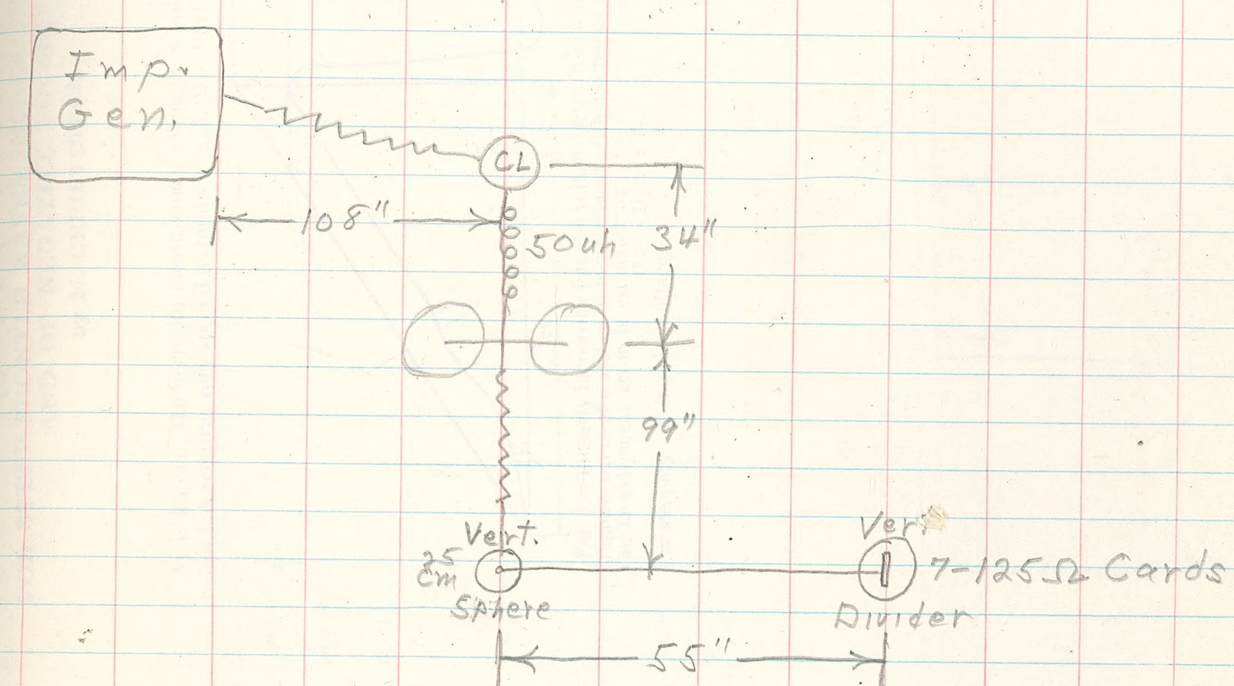

1/15/71
25CM SPHERE ; 6CM Gap
(Negative Polarity)
Scatter at
Slow Rates of Rise
Baltimore Curve
Brace found that a small amount of radium salts inside sphere would reduce scatter.
Parks & Cone used a small needle of Co 60 (equivalent to .5 mr/hr at 1m) placed inside top sphere
47ns 3.7%
60ns 4.8%
39ns 7.6%
61ns 12%
37ns 16%
46ns 20%
Calc. Cigre Study Committee #8 (theoretical Curve)
Error = STr = Uoc − Uo
Tr = (Uoc − Uo)/S
(S = KV/ns)
M. Christoffel's Curve using divider with response time of 30 ns
Baltimore Divider 7-125 Ω cards (875 Ω) (divider 55" from sphere)
$\frac{U_{oc} - U_o}{U_o} \times 100 = \%$ error
Tr
Uoc
Uo
Toc
$\frac{U_o - 161}{KV/ns}$
KV/ns
← Slow
fast →


Parks & Cone Divider
$L_H = 2.4$ uh — 2 ns (Time Const.)
$R_H = 10$–$100\ \Omega$ Karma Ribbon
$L_L = .012$ uh — 2.5 ns (Time Const.)
$R_L = 4.8\ \Omega$ Karma Ribbon
25 CM. SPHERE, (6cm. Spacing)
7-125 Ω Hs; 3.99 Ω Shunt divider
Corrected for:
Relative Air Density
Sweep Non-Linearity
(Baltimore) Divider
$L_H = 28$ uh
$R_H = 7$–$125\ \Omega$ Cards 875 Ω
81 ns time Const.
$L_L = .0265$ uh
$R_L = 4.07\ \Omega$
Ribbon Shunt – 6.57 ns time Const.
Error due to Inductance
$\delta = \frac{\left(\frac{L}{R} - \frac{L_1}{R_1}\right)}{t}$
$R_1 = R_H\ \Omega$
$L_1 = L_H$ Henry
R = Total divider Ω
L = Total " Henry
t = time to Chop
Park & Cone (Negative)
• – 1st interpretation
□ – Latest interpretation (1/11/71)
Neg. Pol
KV Crest
μs
.02
.05
0.1
.2
.5
1
2
5
10
20
50
100
150
160
170
180
190
200
210
220
230
240
250
260
270
280
290

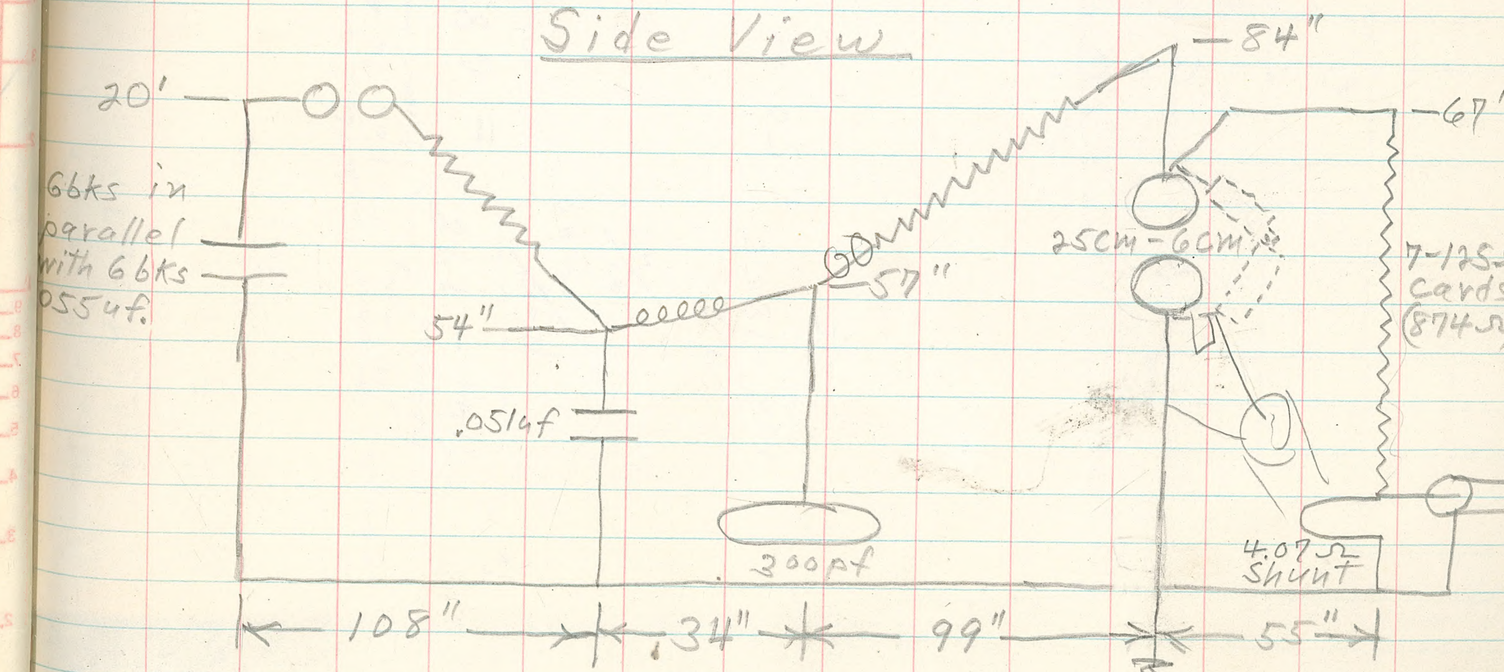


Impulse Circuit

Top View



Side View



of linearly increasing chopped front impulse voltages, the error of measurement is directly proportional to the response time T_r (see *Fig.* 1 and Ref. 3). For a fairly long time and in addition to the usual low voltage method, it has been proposed to determine the response time T_r of a measurement system, by a high voltage method based on the comparison of the measured spark-over characteristic with the actual spark-over characteristic.

$\frac{kV}{\frac{kV}{us}} = \cancel{kV} \times \frac{us}{\cancel{kV}} = us$

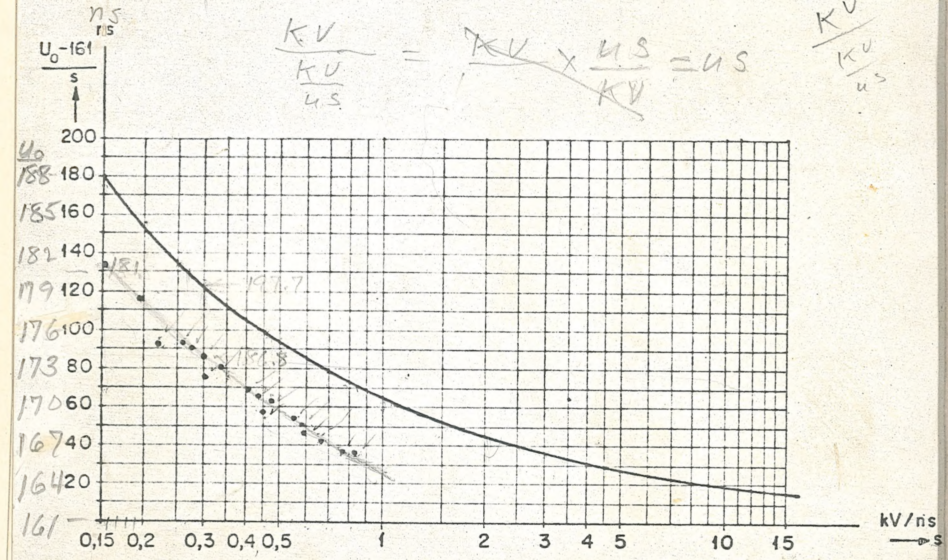


FIG. 2.—Spark-over characteristic of a sphere-gap (s = 60 mm, D = 250 mm) for linearly increasing negative impulse voltages.
The points represent the results of tests with measurement systems having a response time of T_r = 30 ns.
U_o = spark-over voltage 760/20 (kV);
s = steepness (kV ns^{-1}).

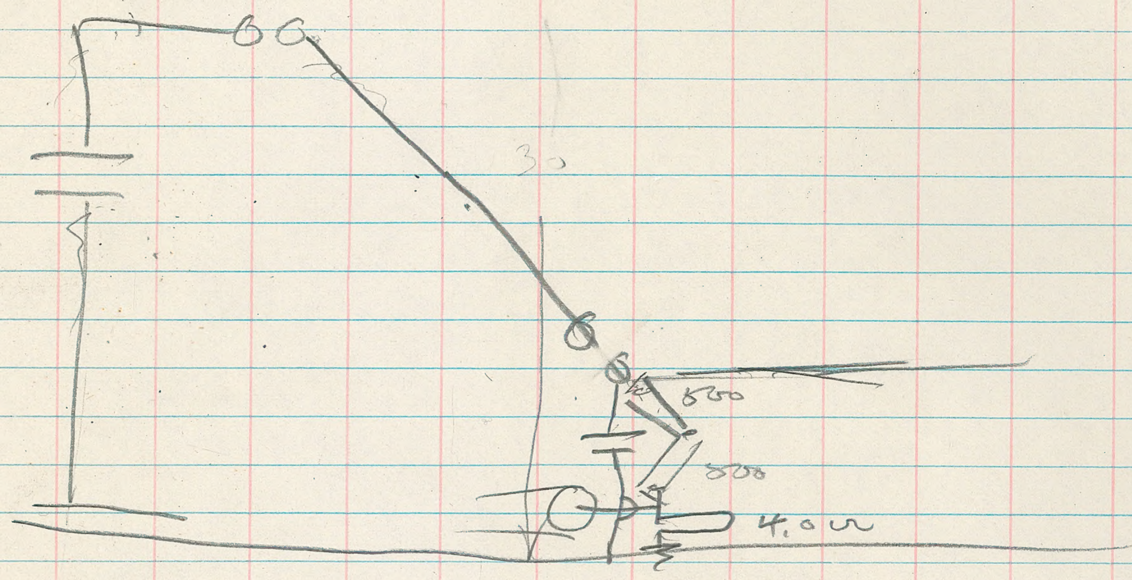
In 1964 a working party of Cigre Study Committee No. 8 requested a certain number of laboratories to record the spark-over characteristics of 2 sphere gaps, with the object of determining on this basis, the actual characteristic with the greatest possible degree of accuracy. This present report deals only with the S = 60 mm, D = 250 mm sphere gap. During the discussion held in Vienna, there were in all 15 series of tests [6]. For the interpretation of these test results, a physical hypothesis was used [5, 6] from which were obtained:

$$\frac{(U_{oc} - a_2)^2}{s} = \text{constant.} \tag{1}$$

If the hypothesis is true, for a measurement system having a response time $T_r = c_2$, the following equation is obtained:

$$\frac{U_o}{s} = a_2 \cdot \frac{1}{s} + b_2 \cdot \sqrt{\frac{1}{s}} + c_2. \tag{2}$$

$\frac{U_o}{s} = 161 \times \frac{1}{s} + b_2 \times \sqrt{\frac{1}{s}} + c_2$



200 376

$\frac{200}{376} \times 150\,kV \times 6$

135
50

1

900

600×10^2

$\frac{6 \times 10^5}{10^3} =$